

Digital network-centric systems of data management in civil shipbuilding organizations: development and implementation

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Abstract—The long-term development of the Russian economy is inextricably linked with the formation of an effective sectoral structure of production, which involves the active development and implementation of technological innovations that underlie the creation of high-tech products. Russian civil shipbuilding as a backbone branch of the domestic industry, producing high-tech products with a high share of added value, is no exception. The key to the current and prospective increase in the competitiveness of Russian civil shipbuilding products in the domestic and foreign markets directly depends on the implementation of advanced technological innovations, including the field of accumulation and processing of information data to ensure the adoption of more effective management decisions.

Keywords—network-centric systems, data management, information resources, civil shipbuilding, design

I. INTRODUCTION

Modern civil shipbuilding is a backbone branch of the Russian economy, producing high-tech and competitive products that are in demand in the domestic and foreign markets.

The prospective development of the civil shipbuilding industry in Russia is directly associated with the effective implementation of technological innovations at all stages of the life cycle of manufactured industrial products. The digitalization of design, construction, and production everywhere acts as a key driver for increasing labor productivity at enterprises and organizations of the industry, making a significant contribution to ensuring the required growth rates of output [1,2,3,4,5,6].

Today, the most acute need for new and more advanced tools for the accumulation and processing of management information is observed in the segment of design organizations that provide the required level of R&D, in particular - in the sphere of production of cost calculations and data management on the cost of projected civil shipbuilding facilities.

In this regard, the dynamic development of information technologies makes new requirements for the organization of the pricing process and the calculation of the cost of civil shipbuilding products - the effective provision of industry

cost calculations.

This article presents methodological approaches to the development and implementation of digital network-centric data management systems in civil shipbuilding organizations in order to increase the efficiency of pricing of industry products, including the conceptual framework, basic principles, and basic tools for their implementation.

In this paper, using general methods of scientific knowledge in various aspects, the processes of digital transformation of civil shipbuilding in Russia are considered. The article reveals the features typical for the sphere of pricing and calculating the cost of civilian shipbuilding products. The author's developments in terms of design for the designated area of a promising tool are presented - a digital network-centric data management system.

II. THE CONCEPT OF A "DIGITAL NETWORK-CENTRIC DATA MANAGEMENT SYSTEM"

The emergence of the concept of network centrism is associated with the publication in Proceedings magazine in 1998 of the article "Network Centric Warfare: It's Origin and Future", which was authored by John Garstka and Arthur Cebrowski [7]. The concept presented in this article was further developed in the work "Network Centric Warfare: Developing and Leveraging Information Superiority" in collaboration with David Alberts and Frederick Stein [8].

The term "network-centric" was used by the authors to define a model of warfare based on the principle of building a system consisting of three subsystems: information, sensory, and combat. The current understanding of the term "network-centric" interprets it as follows: "referring to / or meaning the characteristic property of a reliable, globally interconnected network environment (including infrastructure, systems, processes, and people) in which data for sharing is made available to users, applications, and platforms in a timely and seamless manner." [9,10,11].

The network-centric environment is formed by three elements: a physical block, an information block, and a knowledge block. The physical block includes hardware and software tools, the information block includes the semantics and syntax of the environment, and the knowledge block combines the cognitive and social mechanisms of the system (Fig. 1) [6,10,11].

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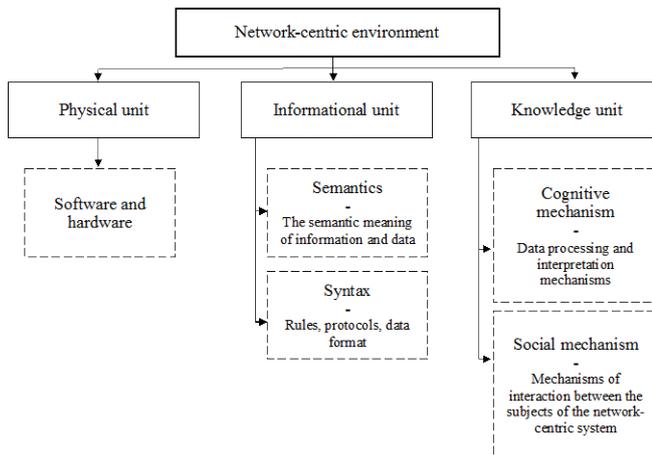


Fig 1. Elements of the environment of the network-centric system

Based on the generalization of modern views on network centrism, we will give an up-to-date definition of a digital network-centric data management system contextually to civil shipbuilding.

A digital network-centric data management system in civil shipbuilding should be understood as such a model for organizing software and hardware mechanisms and means for managing information resource flows, which is characterized by distributed network control and emergence - the effect of manifestation in the system as a whole of qualities and properties that are not characteristic of each individual its element considered separately [12].

The key principles for the implementation of the digital network-centric data management system include scalability, reliability, adaptability, and data unification [13, 14, 15].

The principle of scalability assumes the ability of the digital network-centric data management system to withstand the increase in workload - to increase performance in the face of increasing hardware resources.

The principle of reliability lies in the ability of the digital network-centric data management system to perform the required functionality under specified conditions for a period of time specified by users.

The principle of adaptability implies that the digital network-centric data management system should be built taking into account the technical possibility of changing the configuration of its basic parameters, as well as the number of its interested users.

The principle of data unification consists in orienting the functioning of the digital network-centric data management system to uniform formats for their loading, processing and unloading for the purposes of optimization and increasing the efficiency of managerial decision-making.

III. APPLICATION OF NETWORK-CENTRIC DIGITAL SYSTEMS FOR CALCULATING THE COST OF CONSTRUCTION OF DESIGNED FACILITIES AND MANAGING THE FLOW OF VALUE INFORMATION BY DESIGN BUREAUS IN THE SPHERE OF CIVIL SHIPBUILDING

Digital network-centric data management systems, developed taking into account the requirements of civil shipbuilding design organizations, should provide support for updating and updating data in real time for each design

stage. Such data will be of interest not only for designers, but also for other participants in the process of creating and maintaining civil shipbuilding facilities.

Digital network-centric data management systems are focused not only on improving the efficiency of the development of project documentation, but also designed to ensure the exchange of information on the design, construction, and maintenance of civil shipbuilding facilities at the entire stage of their life cycle between all interested participants in such a process.

The use of the digital network-centric data management system presupposes the optimization of the processes of development, transfer, and approval of cost calculations and accompanying documentation within the framework of the intra-project interaction of the parties in the coordinates "customer - designer - performer".

As the analysis shows, in general, digital network-centric data management systems are able to create a number of advantages and related effects at all stages of calculating the cost of projected objects in the field of civil shipbuilding.

So, among the obvious advantages here should be highlighted:

- access to resources to collect and manage diverse design information used in the preparation of cost estimates;

- increasing the speed, intensity, and efficiency of information exchange between the interacting parties;

- unification of forms and regulations for the development of cost documentation and presentation of information.

The implementation of the above advantages allows you to achieve the following effects:

- a significant increase in the effectiveness of the work of designers in the search and processing of information necessary (required) for the assessment;

- reducing collisions and errors in the costing process, increasing the accuracy of cost estimates;

- a significant reduction in the time and cost of preparing project documentation;

- effective provision of timely preparation of materials for analytical, statistical, and financial reporting based on cost documentation, achievement of a qualitatively new level of awareness of the parties about the specifics of the project cost structure;

- increasing the transparency of cost justification and control procedures;

- optimization of the processes of verification of cost calculations, audit, and acceptance of project documentation.

Taking into account the specific features of pricing in the shipbuilding industry, the typical data for the exchange between the interacting parties through the digital network-centric data management system are:

- on the part of design organizations - single and complex forecast cost estimates, project documentation (estimates, cost estimates, cost calculations, and accompanying materials), procurement and tender documentation, reference and analytical reports, etc.;

- on the part of shipbuilding enterprises and shipyards - rationing of time, wage rates by type of work, information about the specifics of working conditions, as well as other input information required for the purpose of clarifying cost calculations for local construction conditions;

on the part of the client - resolutions, comments, requirements for documentation issued by the parties, technical and commercial proposals of approved suppliers, conditions and requirements for calculating the cost, as well as other information used to form the final estimate of the cost of the product.

Table 1, as an example, a typical local calculation module of the digital network-centric data management is presented, which can be used in the interests of calculating the cost of building a standard floating object designed and produced in the field of civil shipbuilding.

Calculation items:	Areas of responsibility:
Purchases:	Submodule for calculating the cost of purchases
- materials	
- equipment	
- cable	
- supply, etc	
Production (labor) costs:	Submodule for calculating labor costs
- for work performed at the plant / shipyard	
- for work performed afloat	
- for work on manufacturing of special equipment (construction and electrical installation)	
Other works	Submodule for issuing the object estimate
Purchase and project management	
In total	

In general, the logic of performing work by means of the presented local calculation module of the digital network-centric data management will be illustrated in Fig 2.

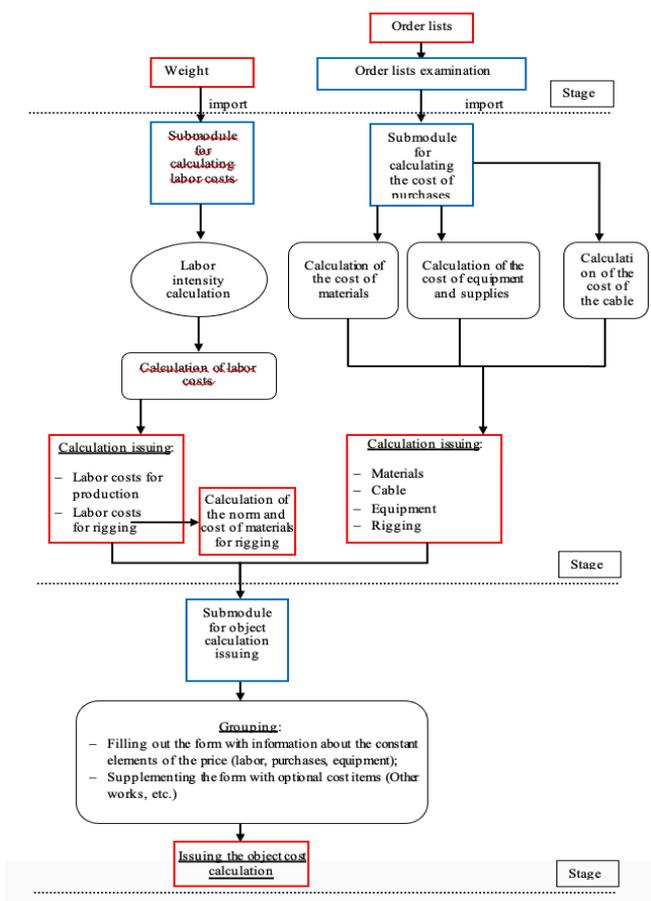


Fig. 2. The digital network-centric data management

As it follows from Fig 2, digitalization and automation of cost calculations by means of the digital network-centric data management system allows you to achieve a systematic and orderly shipment of data streams for their subsequent processing, comprehensive analysis, and making more effective and balanced management decisions.

A substantiated assessment of labor costs for the operations being laid, the analysis of the effectiveness of building chains of industrial cooperation, the identification of patterns in the implementation of design solutions, taking into account the local features of the objects being created in the field of civil shipbuilding - this is not a complete list of applied problems, which are targeted by the digital network-centric data management system.

IV. CONCLUSION

Today shipbuilding is going through series of iterative changes in production and business processes, management methods, technical and technological bases. These processes are necessary for the development and existence of the industry, since competitive production invariably needs to optimize the cycles of creating new products, quickly putting them on the market, occupying new market niches, identifying and meeting the requirements of customers.

Therefore, from the entire set of advanced technologies, shipbuilders strive to select and adapt to their needs those innovations that will help speed up and optimize work processes, raise the level of production efficiency, and reduce costs.

To date, the most discussed and top priority area for the development of domestic civil shipbuilding is the digital transformation of production processes at all stages of the life cycle of an object created in the industry.

The digital network-centric systems of data management are considered to perform as a key connecting element in the implementation of the principles of digital transformation. They are a natural result of the search for ways of the most efficient procedures of accumulation, exchange, and processing of data in an apportioned system organization. They are ready to provide users with radically new opportunities for effective interaction, to ensure the implementation of a smooth transition to digital platforms in the future - the anticipated final stage of the digital transformation of the industry.

Nowadays, there are such tasks, for the solution of which it would be beneficial to create and use network-centric systems of data management, and, what is extremely important - there are opportunities for creating such tools.

In this paper, a concept model of a typical network-centric system of data management is presented. It has been modeled to provide the minimum necessary functionality, which allows in a semi-automated form to carry out the current work on calculating the cost of projected objects, to save and exchange the accumulated price information in accordance with the regulations established in the cluster.

In this context, it has been established that network-centric systems of data management allow bringing to a new

level the speed and accuracy of carrying out cost estimates; help owners of specific data to concentrate disparate information within a modern digital set of tools, supplement it with fresh information from other members of the network-centric cooperation.

All this provides ample opportunities for the collection and systematization of quantitative estimates of the costs of designed objects with reference to their characteristics, design features, conditions for the localization of construction. The use of network-centric systems of data management can be found in such conditions as within the enterprise, where the key nodes of the system act as "experts", advising and promptly providing valuable information to specialists in the course of work; and within the framework of an associative union (such as cluster).

Summing up, the use of the digital network-centric data management system in the interests of carrying out cost calculations at enterprises and organizations in the civil shipbuilding sphere will ensure a better collection of industry statistics, increase the efficiency of the process of calculating the cost of industrial products as a whole, and create a significant backlog in the direction of digital transformation of the industry - large-scale digitalization of technological processes in civil shipbuilding.

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